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Prevalence of Metabolic Syndrome Among Adults 20 Years of Age and Over, by Sex, Age, Race and Ethnicity, and Body Mass Index: United States, 2003–2006

by R. Bethene Ervin, Ph.D., R.D., Division of Health and Nutrition Examination Surveys

Abstract

Objective—The purpose of this study was to examine the prevalence of individual risk factors for metabolic syndrome as well as the prevalence of metabolic syndrome in the National Health and Nutrition Examination Survey (NHANES) 2003–2006.

Methods—The analytic sample consisted of 3,423 adults, 20 years of age and over, from NHANES 2003–2006. The National Cholesterol Education Program's Adult Treatment Panel III (NCEP/ATP III) guidelines were used to identify adults who met their criteria for metabolic syndrome. Prevalence estimates were calculated for each risk factor for metabolic syndrome in addition to the prevalence of metabolic syndrome. Prevalence estimates and odds ratios were analyzed by sex and by age group, race and ethnicity, and body mass index (BMI) stratified by sex.

Results—Approximately 34% of adults met the criteria for metabolic syndrome. Males and females 40–59 years of age were about three times as likely as those 20–39 years of age to meet the criteria for metabolic syndrome. Males 60 years of age and over were more than four times as likely and females 60 years of age and over were more than six times as likely as the youngest age group to meet the criteria. Non-Hispanic black males were about one-half as likely as non-Hispanic white males to meet the criteria for metabolic syndrome, while non-Hispanic black and Mexican-American females were about 1.5 times as likely as non-Hispanic white females to meet the criteria. Overweight males were about six times as likely and obese males were about 32 times as likely as normal weight males to meet the criteria. Overweight females were more than five times as likely and obese females were more than 17 times as likely as normal weight females to meet the criteria.

Conclusions—These results demonstrate that metabolic syndrome is prevalent and that it increases with age and with BMI. The prevalence varied by race and ethnicity but the pattern was different for males and females.

Keywords: National Health and Nutrition Examination Survey (NHANES) • metabolic syndrome • BMI • abdominal obesity

Introduction

The National Cholesterol Education Program's Adult Treatment Panel III (NCEP/ATP III) report identified metabolic syndrome as a constellation of risk factors that increase a person's risk of developing cardiovascular disease (CVD) (1,2). ATP III identified six components of the metabolic syndrome that relate to CVD (1,2):

- Abdominal obesity
- Atherogenic dyslipidemia (elevated triglyceride, small LDL particles, low HDL cholesterol)
- Raised blood pressure
- Insulin resistance (with or without glucose intolerance)
- Proinflammatory state
- Prothrombotic state

According to ATP III, a diagnosis of the metabolic syndrome is made when three or more of the risk factors shown in Table 1 are present (1,2). The purpose of this study was to examine the prevalence of the individual risk factors for metabolic syndrome as well as the prevalence of metabolic syndrome by sex in the National Health and Nutrition Examination Survey (NHANES) 2003–2006. The prevalence of these risk

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factors and of metabolic syndrome was also analyzed by age group, race and ethnicity, and body mass index (BMI) stratified by sex.

Methods

Sample population

NHANES is a cross-sectional nationally representative health and nutrition examination survey conducted by the Centers for Disease Control and Prevention's National Center for Health Statistics. The survey design is a complex, stratified, multistage probability sample of the U.S. civilian, noninstitutionalized population. NHANES 2003–2006 includes over samples of low-income persons, adolescents 12–19 years of age, persons 60 years of age and over, African-American persons, and Mexican-American persons to improve the precision of the estimates for these groups.

A total of 13,635 adults 20 years of age and over were eligible to participate in NHANES 2003–2006. The survey includes an interview conducted in the home and a subsequent health examination performed at a mobile examination center (MEC). Of the eligible sample, 10,020 adults 20 years of age and over (73%) participated in the household interview and 9,515 (70%) also participated in the MEC exam.

Only adults 20 years of age and over who participated in the household interview, the MEC exam, and the morning fasting subsample were included in the analytic sample (n=3,959). Pregnant and lactating females (n=264) were deleted from the analytic sample. In addition, 272 participants were deleted because they were missing information or their answers were incomplete or were flagged as not reliable. Weighted unit and item nonresponse analysis indicated no systematic bias due to gender, age, race and ethnicity, or BMI. The final analytic sample consisted of 3,423 adults.

Definition of metabolic syndrome

The NCEP/ATP III revised guidelines shown in Table 1 were used to identify adults in the analytic sample who had metabolic syndrome (2). In addition, individuals who reported currently taking antihypertensive medication were classified as having high blood pressure and individuals currently taking insulin or an oral hypoglycemic medication were classified as having diabetes. According to these guidelines, metabolic syndrome is defined as the presence of three or more of these risk factors.

Height, weight, and waist circumference were all measured in the MEC using standardized techniques and calibrated equipment. A certified phlebotomist drew fasting morning blood samples from the examinee's arm for the lipid and glucose assays. Standardized techniques were used to obtain the blood pressure measurements. The average of up to three brachial systolic and diastolic blood pressure readings was used for the systolic and diastolic blood pressure values. Detailed descriptions of the anthropometric, venipuncture, and blood pressure measurement procedures can be found in the anthropometry, laboratory, and physician examination procedures manuals (3–5).

Descriptive characteristics

The prevalence of the individual risk factors for metabolic syndrome and the prevalence of metabolic syndrome by sex are reported as well as by age group, race and ethnicity, and BMI stratified by sex. Crude and age-adjusted estimates are presented for the total population. Age-adjusted estimates are presented for sex, race and ethnicity, and BMI. Age adjustment was performed using the direct method of adjustment to the U.S. resident population, ages 20 years and over, estimated by the U.S. Census Bureau in the year 2000 (6). Age group was controlled when examining the odds ratios (OR) for sex, race and ethnicity, and BMI.

Age was categorized into three groups based on the recommendations in the NHANES Analytic Guidelines (7). These categories were: 20–39 years, 40–59 years, and 60 years of age and over. These three age categories were also used in the age-adjustment procedure.

Results are reported for non-Hispanic white persons, non-Hispanic black persons, and Mexican-American persons. Individuals who did not identify themselves as belonging to one of these categories were not analyzed separately but were included in the "Total" category.

BMI measures relative weight for height. BMI was calculated by dividing weight by height squared (kg/m^2). Weight categories were created based on the National Heart, Lung, and Blood Institute's classification system (8). The underweight and normal weight categories were combined as well as the obese and extremely obese categories because of limited sample sizes. The three categories used in this analysis were underweight and normal weight (BMI less than 25), overweight (BMI 25–29.9), and obese and extremely obese (BMI 30 or greater).

Data analyses

Data were analyzed using SAS for Windows (release 9.1; SAS Institute Inc., Cary, N.C.) and SUDAAN (release 9.0; Research Triangle Institute Inc., Research Triangle Park, N.C.) statistical software programs. Sample weights were included in the estimation process for all analyses to take into account the differential probabilities of selection, nonresponse, and noncoverage. Standard errors of the percentages were estimated using Taylor series linearization, a method that incorporates the sample weights and accounts for the sample design (9). The relative standard error (RSE) is a measure of an estimate's reliability. The RSE of an estimate is obtained by dividing the standard error of the estimate (SE(r)) by the estimate

itself (r). This quantity is expressed as a percentage of the estimate and is calculated as follows: RSE=100 x (SE(r)/r). Estimates with large RSEs are considered unreliable. Estimates with an RSE of 30% or more are considered highly unreliable and are not shown (indicated by an asterisk (*)). Estimates with an RSE greater than 20% but less than 30% are shown with asterisks (**). These estimates may be unreliable and should be interpreted with caution (7, 10).

Statistical hypotheses were tested at the $p<.05$ level of significance using a two-tailed t statistic. The Bonferroni method of adjustment was used to adjust the critical value for the family of pairwise comparisons across the three levels for age, race and ethnicity, and BMI (11). Logistic regression was used to estimate the odds ratios of metabolic syndrome by sex and by age group stratified by sex. Multiple logistic regression was used to estimate the odds ratios of metabolic syndrome by race and ethnicity and BMI stratified by sex controlling for age group. All differences described in the findings are statistically significant unless indicated otherwise.

Results

Prevalence of risk factors for metabolic syndrome

- Abdominal obesity (53%), hypertension (40%), and hyperglycemia (39%) were the most frequently occurring risk factors for metabolic syndrome, regardless of whether one examined the crude or age-adjusted estimates. Smaller percentages of adults had hypertriglyceridemia (31%) and low HDL cholesterol (25%) (Table 2).
- There were differences in the prevalence of each of the individual risk factors by sex. Males had a higher age-adjusted prevalence of hypertriglyceridemia, hypertension, and hyperglycemia than females, but females had a higher age-adjusted prevalence of abdominal obesity and low HDL cholesterol than males (Table 2).
- There were differences in the prevalence of abdominal obesity, hypertriglyceridemia, hypertension, and hyperglycemia by age group for both sexes. For females, the prevalence of each of these risk factors increased with each succeeding age group. For males, this pattern was only true for hypertension and hyperglycemia. In contrast, males 40 years of age and over were more likely than the youngest age group to have abdominal obesity, but there was no increase in the prevalence of abdominal obesity with age in males 40 years of age and over. Males 40–59 years of age were more likely than those 20–39 years of age to have hypertriglyceridemia, but the prevalence among males 60 years of age and over was not significantly different from that of the other two age groups. There were no significant associations between low HDL cholesterol and age group for either sex (Table 2).
- The age-adjusted patterns for race and ethnicity varied by sex and the risk factor examined. Non-Hispanic white and Mexican-American males had a higher prevalence of hypertriglyceridemia and low HDL cholesterol than non-Hispanic black males. Non-Hispanic white males had a higher prevalence of abdominal obesity than non-Hispanic black males, and non-Hispanic black males had a higher prevalence of hypertension than Mexican-American males. There were no significant associations between hyperglycemia and race and ethnicity for males (Table 2).
- Non-Hispanic black and Mexican-American females had a higher prevalence of abdominal obesity and hyperglycemia than non-Hispanic white females, while Mexican-American females had a higher prevalence of low HDL cholesterol than either of the other two race and ethnic groups. Non-Hispanic black females had a higher prevalence of hypertension than the other two race and ethnic groups, but they had the lowest prevalence of hypertriglyceridemia followed by non-Hispanic white females. Mexican-American females had the highest rate of hypertriglyceridemia (Table 2).
- In general, the prevalence of each of the five risk factors increased as BMI increased for both sexes (Table 2).

Prevalence of metabolic syndrome

- Both the crude and age-adjusted estimates indicate that approximately 34% of the population 20 years of age and over met the criteria for metabolic syndrome (Table 3). There was no significant difference in the prevalence of metabolic syndrome by sex.
- The prevalence of metabolic syndrome increased with each succeeding age group for both sexes. While about 20% of males and 16% of females under 40 years of age met the criteria for metabolic syndrome, 41% of males and 37% of females 40–59 years of age and 52% of males and 54% of females 60 years of age and over met the criteria. Males and females 40–59 years of age were about three times as likely as the youngest age group to meet the criteria for metabolic syndrome (males: OR=2.70; 95% confidence interval (CI): 1.96–3.73; females: OR=3.20; 95% CI: 2.32–4.43). Males 60 years of age and over were more than four times as likely as the youngest age group to meet the criteria (OR=4.18; 95% CI: 3.01–5.79), and females 60 years of age and over were more than six times as likely as the youngest age group to meet the criteria (OR=6.44; 95% CI: 4.75–8.72) (Table 3).
- The association between metabolic syndrome and race and ethnicity varied by sex. Twenty-five percent of non-Hispanic black males met the criteria for metabolic syndrome compared with 37% of non-Hispanic white males and were about half as likely as non-Hispanic white males to meet the criteria for metabolic syndrome (OR=0.54; 95% CI: 0.40–0.73). There were no significant differences in the prevalence of metabolic syndrome for females

based on race and ethnicity, but non-Hispanic black and Mexican-American females were about 1.5 times more likely to meet the criteria for metabolic syndrome than non-Hispanic white females (Table 3).

- The prevalence of metabolic syndrome increased with increasing BMI for both sexes. While only about 7% of underweight and normal weight males had three or more risk factors for metabolic syndrome, 30% of overweight males and 65% of obese males met these criteria. Overweight males were more than six times as likely as underweight and normal weight males to meet the criteria for metabolic syndrome (OR=6.17; 95% CI: 3.96–9.62), and obese males were nearly 32 times as likely to meet this criteria (OR=31.92; 95% CI: 20.06–50.78). Slightly more than 9% of underweight and normal weight females, 33% of overweight females, and 56% of obese females had three or more risk factors for metabolic syndrome. Overweight females were nearly 5.5 times as likely as underweight and normal weight females to meet the criteria for metabolic syndrome (OR=5.48; 95% CI: 3.75–8.02), and obese females were more than 17 times as likely to meet this criteria (OR=17.14; 95% CI: 12.54–23.44) (Table 3).

Conclusions

Based on the NCEP/ATP III guidelines, a little more than one-third of the adults in the United States could be characterized as having metabolic syndrome. Metabolic syndrome increased with age but increased even more dramatically as BMI increased. The prevalence of metabolic syndrome varied by race and ethnicity but the pattern was different for males and females. Non-Hispanic black males were less likely than non-Hispanic white males to have metabolic syndrome but non-Hispanic black and Mexican-American females were more likely than non-Hispanic white females to have it. Among the five diagnostic criteria for metabolic syndrome abdominal obesity, hypertension, and hyperglycemia were the most prevalent.

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Table 1. ATP III clinical identification of the metabolic syndrome

Risk factor	Defining level
Abdominal obesity (waist circumference):	
Men	>102 cm (>40 in)
Women	>88 cm (>35 in)
Triglycerides	≥150 mg/dL
HDL cholesterol:	
Men	<40 mg/dL
Women	<50 mg/dL
Blood pressure	≥135/≥85 mm Hg
Fasting glucose	≥100 mg/dL

NOTES: ATP III is Adult Treatment Panel III. Table taken from: Grundy SM, Brewer HB, Cleeman JI, Smith SC, Lenfant C. Definition of metabolic syndrome. Report of the National Heart, Lung, and Blood Institute/American Heart Association Conference on scientific issues related to definition. Circulation. 109:433–8. 2004(2).

Table 2. Prevalence of individual risk factors for metabolic syndrome among adults 20 years of age and over by selected characteristics: United States, 2003–2006

Characteristic	Number of subjects	Abdominal obesity		Hypertriglyceridemia		Low HDL cholesterol		High blood pressure or medication use[1]		High fasting glucose or medication use	
		Percent	Standard error	Percent	Standard error	Percent	Standard error	Percent	Standard error	Percent	Standard error
Total, crude[2]	3,423	53.2	(1.3)	31.4	(1.0)	24.7	(0.9)	40.0	(1.3)	39.0	(1.9)
Total, age-adjusted[2,3]	3,423	52.8	(1.1)	31.2	(1.0)	24.7	(0.9)	39.5	(1.1)	38.6	(1.6)
Sex[3]											
Male	1,794	44.8	(1.3)[a 4]	35.6	(1.5)[a]	21.6	(1.5)[a]	43.4	(1.4)[a]	45.8	(1.8)[a]
Female	1,629	60.7	(1.6)[b]	26.5	(1.1)[b]	27.8	(1.5)[b]	35.2	(1.3)[b]	31.3	(1.7)[b]
Male											
Age											
20–39 years	607	32.0	(2.2)[a 4]	29.6	(2.1)[a]	21.4	(2.5)	24.1	(2.0)[a]	28.8	(1.8)[a]
40–59 years	546	52.1	(2.5)[b]	41.5	(2.5)[b]	23.0	(1.9)	44.5	(2.7)[b]	50.3	(3.3)[b]
60 years and over	641	55.2	(2.4)[b]	36.7	(2.1)[a,b]	19.5	(1.3)	74.4	(2.7)[c]	67.8	(1.9)[c]
Race and ethnicity[3]											
Non-Hispanic white	967	47.4	(1.4)[a 4]	36.6	(1.7)[a]	22.6	(1.9)[a]	43.5	(1.7)[a,b]	44.8	(2.2)
Non-Hispanic black	346	36.0	(2.9)[b]	21.2	(2.4)[b]	11.5	(1.6)[b]	51.3	(2.8)[a]	40.9	(2.3)
Mexican American	364	37.6	(3.6)[a,b]	43.7	(2.8)[a]	26.0	(2.8)[a]	35.5	(2.7)[b]	49.8	(3.1)
Body mass index (BMI)[3]											
Underweight and normal weight	532	*	*	18.0	(2.2)[a]	**9.4	(1.9)[a]	32.0	(1.8)[a]	35.0	(2.7)[a]
Overweight	701	35.1	(1.8)[a 4]	37.7	(1.8)[b]	22.6	(2.7)[b]	40.3	(2.2)[b]	45.0	(2.2)[b]
Obese and extremely obese	557	94.4	(1.1)[b]	48.6	(2.7)[c]	31.3	(3.3)[b]	57.5	(2.4)[c]	55.5	(2.0)[c]
Female											
Age											
20–39 years	488	49.8	(2.7)[a 4]	17.8	(2.0)[a]	29.4	(2.5)	6.8	(1.2)[a]	13.4	(1.5)[a]
40–59 years	542	64.1	(2.2)[b]	27.3	(1.7)[b]	29.4	(2.4)	43.2	(2.2)[b]	35.5	(3.0)[b]
60 years and over	599	74.0	(2.6)[c]	40.1	(3.0)[c]	22.7	(2.2)	71.0	(2.6)[c]	55.1	(2.7)[c]
Race and ethnicity[3]											
Non-Hispanic white	846	58.0	(2.3)[a 4]	27.3	(1.5)[a]	27.6	(2.1)[a]	33.0	(1.5)[a]	28.7	(2.0)[a]
Non-Hispanic black	348	76.3	(2.1)[b]	14.4	(1.8)[b]	26.8	(2.7)[a]	53.4	(2.8)[b]	38.7	(2.4)[b]
Mexican American	306	74.9	(3.3)[b]	34.6	(2.1)[c]	39.6	(3.3)[b]	32.1	(3.0)[a]	41.7	(3.8)[b]
Body mass index (BMI)[3]											
Underweight and normal weight	519	13.6	(1.5)[a 4]	12.9	(1.3)[a]	12.9	(1.7)[a]	26.4	(1.9)[a]	15.8	(1.7)[a]
Overweight	474	77.7	(3.1)[b]	32.3	(3.0)[b]	30.5	(1.8)[b]	31.7	(1.9)[a]	31.2	(2.3)[b]
Obese and extremely obese	634	99.6	(0.2)[c]	36.8	(1.8)[b]	43.1	(2.8)[c]	46.8	(2.6)[b]	46.9	(2.5)[c]

* Indicates a relative standard error of 30% or more. These estimates are considered highly unreliable and are not shown (7,10).

** Indicates a relative standard error greater than 20% but less than 30%. These estimates may be unreliable and should be interpreted with caution (7,10).

[1]Blood pressure measurement is the average of up to three blood pressure readings.

[2]Total includes racial and ethnic groups not shown separately plus respondents with missing BMI values.

[3]Age-adjusted estimates. Age adjustment was performed using the direct method of adjustment to the 2000 U.S. Census figures.

[4]$p < 0.05$. Letters that are different from each other indicate significant differences. Comparisons involving three categories were adjusted for multiple comparisons using the Bonferroni method of adjustment.

Table 3. Prevalence of metabolic syndrome and odds ratios for prevalence of metabolic syndrome among adults 20 years of age and over by selected characteristics: United States, 2003–2006

Characteristic	Percent	Standard error	Odds ratio (95% confidence interval)	
Total, crude[1]	34.4	(1.3)	– – –	– – –
Total, age adjusted[1,2]	34.0	(1.1)	– – –	– – –
Sex[2]				
Male	35.1	(1.3)	1.00	– – –
Female	32.6	(1.6)	0.89	(0.73 to 1.07)
			Male	
Age				
20–39 years	20.3	(2.0)[a 3]	1.00	– – –
40–59 years	40.8	(2.1)[b]	2.70	(1.96 to 3.73)
60 years and over	51.5	(3.1)[c]	4.18	(3.01 to 5.79)
Race and ethnicity[2]				
Non-Hispanic white	37.2	(1.6)[a 3]	1.00	– – –
Non-Hispanic black	25.3	(2.0)[b]	0.54	(0.40 to 0.73)
Mexican American	33.2	(2.9)[a b]	0.78	(0.57 to 1.07)
Body mass index (BMI)[2]				
Underweight and normal weight	6.8	(1.1)[a 3]	1.00	– – –
Overweight	29.8	(2.0)[b]	6.17	(3.96 to 9.62)
Obese and extremely obese	65.0	(2.4)[c]	31.92	(20.06 to 50.78)
			Female	
Age				
20–39 years	15.6	(1.8)[a 3]	1.00	– – –
40–59 years	37.2	(2.6)[b]	3.20	(2.32 to 4.43)
60 years and over	54.4	(2.8)[c]	6.44	(4.75 to 8.72)
Race and ethnicity[2]				
Non-Hispanic white	31.5	(2.2)	1.00	– – –
Non-Hispanic black	38.8	(2.1)	1.44	(1.05 to 1.98)
Mexican American	40.6	(2.5)	1.55	(1.06 to 2.29)
Body mass index (BMI)[2]				
Underweight and normal weight	9.3	(0.9)[a 3]	1.00	– – –
Overweight	33.1	(2.9)[b]	5.48	(3.75 to 8.02)
Obese and extremely obese	56.1	(2.6)[c]	17.14	(12.54 to 23.44)

– – – Category not applicable.

[1]Total includes racial and ethnic groups not shown separately plus respondents with missing BMI values.

[2]Age adjusted percentages and standard error. The logistic regression models controlled for age group. Reference groups for logistic regression: sex—males; age—20–39 years; race and ethnicity—Non-Hispanic white; body mass index—underweight and normal weight.

[3]$p<0.05$. Adjusted for multiple comparisons using the Bonferroni method of adjustment when three levels were examined. Letters that are different from each other indicate significant differences.

Suggested citation

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